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A Study of Exhaust Emissions from Twenty High Mileage Oldsmobile Diesel Passenger Cars

(U.S.) Environmental Protection Agency
Ann Arbor, MI

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A Study of Exhaust Emissions from Twenty High Mileage Oldsmobile Diesel Passenger Cars.

by
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March, 1980

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air, Noise, and Radiation
U.S. Environmental Protection Agency

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This paper describes the results of an exhaust emission testing program conducted by EPA on twenty diesel-powered Oldsmobile passenger cars. Each was a full-size 1978 model equipped with the 350 CID engine. The primary purpose of this program was to assess the emission durability of this engine which was originally designed to operate on gasoline. Secondary objectives included an evaluation of fuel economy, measurement of particulate emissions and gathering of samples for subsequent Ames Test analyses.

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ABSTRACT

This paper describes the results of an exhaust emission testing program conducted by EPA on twenty diesel-powered Oldsmobile passenger cars. Each was a full-size 1978 model equipped with the 350 CID engine (Family Designation: 830J9). The primary purpose of this program was to assess the emission durability of this engine which was originally designed to operate on gasoline. Secondary objectives included an evaluation of fuel economy, measurement of particulate emissions and gathering of samples for subsequent Ames Test analyses.

The test vehicles were drawn from the general public in the Detroit area using direct mail solicitation. Only vehicles with over 40,000 miles were sought. This resulted in an average odometer reading for the test fleet of 48,195 miles. The tests performed included the Federal Test Procedure, the Highway Fuel Economy Test and several short tests. The program began in December 1979 and was completed in February, 1980. Testing was performed at the EPA's Motor Vehicle Testing Laboratory in Ann Arbor.

The average emission test results were quite similar to those resulting from the Certification process at 4,000 miles. Thus, it appears that the 350 CID Oldsmobile diesel engine demonstrates virtually no emission deterioration while in-use over its "useful life". City and Highway fuel economy values were also found to correspond closely with those published in the 1978 Gas Mileage Guide. Average particulate emissions of these diesels were found to be approximately 50% greater than the initial standard of 0.6 g/mile which is to become effective with the 1982 model year. Results from analyses of the Ames Test samples have not been received and will be treated as a supplement to this report.

Introduction

Although the diesel engine has long been recognized as a durable and fuel-efficient powerplant, its use in passenger cars had been limited because of a number of factors, primarily, weight, cost and noise. Prior to the 1978 model year, there were no major American manufacturers involved in the production of diesel passenger cars. The changing economic and political situation, especially with regard to energy costs and fuel economy legislation, has made this concept more feasible. With the introduction of General Motors' 5.7 liter (350 CID) diesel engine, the possiblity of large numbers of diesel-powered passenger cars in operation became real. The initially rapid sales rate of these vehicles was further enhanced by rising gasoline prices and fears of fuel shortages. Currently, sales of these vehicles total about 300,000 units per year. While this represents only about 3% of the passenger car market, sales of diesels have been so successful that General Motors has predicted that up to 30 percent of its production may be committed to diesels in the next three to four years.

Although the Oldsmobile diesel successfully completed all requirements for EPA certification, there is little known about the emission characteristics of these engines once they have been used by private owners. There is concern not only for the regulated pollutants, but also for particulate emissions for which there was no standard in 1978. The type of particulate matter produced by internal combustion engines is known to cause genetic damage to living cells and diesel engines have been found to produce a significantly greater amount of particulates than gasoline engines. At this time, some of these 1978 versions are reaching the 50,000 miles prescribed as their "useful life".

On the basis of the facts above, an EPA test program was designed during the Fall of 1979. The primary purpose of this program was to assess the emission durability of the Oldsmobile 350 CID diesel engine. Secondary objectives included an evaluation of fuel economy, measurement of particulate emissions and gathering of samples for subsequent Ames test analyses. Since this was the first program in which test vehicles would be recruited directly from private owners, close attention would also be paid to documenting procurement techniques and recording response rates. The test plan provided for twenty in-use diesel-powered Oldsmobile passenger cars. Each of these was to have accrued at least 40,000 miles. The vehicles would be procured from the general public and tested at the Motor Vehicle Emission Laboratory in Ann Arbor.

Vehicle Procurement Technique

Over a two month period, solicitation packages were mailed to owners of 301 Oldsmobiles and 27 Peugeots*. This represented all such 1978 models registered in Wayne, Oakland, Macomb, St. Clair, Lapeer, and Livingston County as of September 1979. Names and addresses of owners of candidate vehicles were purchased from R.L. Polk Co. at an average cost of $.85 per name. The package included a letter and a postpaid reply card with which an owner could

* Volkswagen owners were not sought for this program because the VIN does not include an identifier to separate diesels from gasoline engines.

report vehicle information and express his willingness to participate. A brochure was also included describing the EPA laboratory and its operation. Owners whose cars were ultimately chosen were offered the basic incentives of a $50 Savings Bond, a loan car and a full tank of fuel upon return of their vehicle. EPA also offered to exchange cars at their convenience and promised a summary of the test results on their vehicle. Copies of these letters and the reply postcard are attached as Appendix A.

Responses were received from 175 Oldsmobile owners and 14 Peugeot owners. Figure 1 is a histogram of the responses versus time for the Oldsmobiles. Over 70% of the responses were received within ten days of the mailing. Of these responses, most indicated a willingness to participate in our program. Thus, a positive response rate of 48% and 35%, respectively was obtained of all Oldsmobile and Peugeot owners contacted. Since EPA was seeking vehicles with the highest mileage, these responses were ranked by odometer readings. Figure 2 is a histogram of the mileages reported by the Oldsmobile owners. Darkened squares indicate the vehicles which were ultimately tested. All of the test vehicles were full-size Oldsmobiles (88, 98, Custom Cruiser) with the 350 CID engine (Family Designation: 830J9). None of the Peugeot owners reported odometer readings over the 40,000 miles which was established as a cutpoint for "high mileage". In a follow-up mailing to positive respondents who were not chosen, EPA thanked them for their interest, described the current program, and offered them a chance to update the information on their vehicle.

As an additional evaluation of the procurement techniques, 40 special solicitation packages were sent out. Each of these was paired with a standard package which was also sent to the owner in the same Zip Code. The special package included an original typed letter with the owners' name and address, a handwritten signature, and a reference to his Oldsmobile. The standard letter was printed and only included "Dear Vehicle Owner" and "your vehicle" in its opening. The response rate from the special packages was 45% while that for the 40 standard packages was 40%. Thus, it appears that the extra effort in this area was unwarranted in terms of response rate.

The actual acquisition of the vehicles was handled by Emission Factor Program personnel. Two 1979 Cutlasses were leased for use as loaner cars. Lee Oldsmobile, the lessor, also purchased and mailed the bonds. Test vehicles were brought in at a rate of two per week with an average time from pick up to return of 4 days. The twenty vehicles required 40 exchanges of cars. 23 of these were handled at the owner's residence or place of business. The remaining transfers were conducted at MVEL. Both the loaners and test vehicles were washed, vacuumed and filled with fuel before they were given to the participant.

At the initial meeting, the principal driver was asked to complete a short questionnaire and fill out several forms related to the exchange of vehicles. Copies of these are attached in Appendix B. Only two exchanges were aborted. One occurred when the participant was not at home for a scheduled meeting. The other was postponed by the owner in advance. In general, vehicle procurement was quite successful.

Participant Profile

Almost all of the vehicle owners are involved in outside sales or commute long distances to work. All said they were concerned with fuel economy and half kept detailed records of fuel usage. Most owners were satisfied with the performance of their vehicle's engine although some had experienced major problems with injector pumps, injectors, transmissions and cooling lines, as well as minor annoyances such as oil leaks. All felt that they had maintained their vehicles in accordance with manufacturer's recommendations. A listing of these responses is attached as Appendix C.

Vehicle Testing

Once each vehicle was acquired, appropriate sections of a standard MVEL test data sheet were completed and the keys delivered to the Evaluation and Development (E&D) group for testing. An E&D technician prepared the vehicle by rotating tires (when necessary) and increasing tire pressure to 45 psi. Fluid levels were also checked and corrected. No other underhood checks were conducted. The vehicles were tested using tank fuel whenever possible. Extra fuel (Diesel #2) was added from laboratory supplies when necessary to complete the sequence. No fuel was drained nor was the 40% level requirement observed. Preconditioning consisted of a single LA-4 cycle on the dynamometer followed by a 12-24 hour soak period. The dynamometer settings used were as follows:

	Inertia Weight	Horsepower
Oldsmobile 98	4500	12.5
Oldsmobile 88 (Sedan, Coupe)	4500	11.8
Oldsmobile 88 (Station Wagon)	5000	11.3

Each vehicle was tested twice using the following sequence:

1. 1979 FTP for light duty diesels. This included particulate sampling but does not require evaporative emission measurements.

2. "50 Cruise" Test. This short cycle employs garage instruments to measure tailpipe concentrations of HC and CO during the 50 mph preconditioning for the HFET.

3. Highway Fuel Economy Test (also with particulate sampling).

4. Four-Speed Idle Test. This short test is comprised of four steady state modes. Idle in neutral, 2500 rpm in neutral, idle in neutral, and idle in drive. Garage instruments are used to sample tailpipe concentrations of HC and CO for each mode.

5. Loaded Two-Mode Test. Sampling is done as before using garage instruments. The first mode is 30 mph at 9 actual dynamometer horsepower. The second mode is idle in neutral.

6. Extra Highway Fuel Economy Cycle (for Ames sampling only).

The testing itself was quite successful. Only one attempt was aborted, and two tests were voided.

Emission Test Results

Complete FTP and HFET results for each vehicle are attached as Appendix D. FTP results and HFET fuel economy values are displayed as histograms in Figures 3-8. Except for HC results on two vehicles, all FTP emission values have been within the 1978 Federal Standards under which they were certified. Despite their high mileage, the average emissions levels of these vehicles were not very different from the levels of Emission Data vehicles tested at 4000 miles. It has also been found that the gaseous emission values gathered in this program compare closely to other diesel testing performed in the FY75 and FY77 Emission Factors programs. In the FY77 program, a total of nineteen Mercedes Benz and one Peugot diesel were tested. In the preceding program, all twenty were Mercedes Benz. The model years ranged from 1964 to 1977 with several mileages exceeding 100,000. Listed in Table 1 are the average emission values of: 1) the original 1978 Oldsmobile 4000 mile certification tests, 2) the vehicles tested in this program and, 3) the vehicles tested in the FY75 and FY77 Emission Factors programs.

Table 1

Average Test Results

			FTP (g/mi)			Fuel Economy (mpg)	
	N	Odom	HC	CO	NO_x	FTP	HFET
Cert/F.E. Guide (Sedan)	1	4,000	.78	1.8	1.90	21	30
This program (Sedans)	18	48782	.80	1.6	1.35	21.5	31.6
Cert/F.E. Guide (Wagon)	1	4,000	1.30	2.1	1.60	19	27
This program (Wagons)	2	42905	1.06	1.9	1.84	19.8	28.7
FY75 Emission Factors (20 Mercedes-Benz diesels)	20	76473	.80	2.2	1.60	23.9	29.8
FY77 Emission Factors (19 Mercedes Benz, 1 Peugeot diesel)	20	86318	1.12	2.9	1.43	24.2	31.3

The data generated from the short cycle tests showed very low emissions with little variance from vehicle to vehicle. These results will not be displayed in chart form but can be found in Appendix E.

Table 2 is a listing of particulate emissions from vehicles in this program compared to results from selected Light Duty Certification Development Vehicles.

Table 2

	FTP Particulates (g/mi)	Percent of 1982 Standard of .6 g/mi	HFET Particulates (g/mi)
Average of the twenty Oldsmobile Diesels in this program:	.85	142	.45
Certification vehicles			
1979 Oldsmobile 350	.84	140	.40
1979 Oldsmobile 260	.73	122	.45
1979 Chevy Pick-up	.59	98	.33
1979 Dodge Pick-up	.61	102	.33
1979 V.W. Dasher	.32	53	.25
1979 V.W. Rabbit	.23	38	.11
1979 Peugeot 540D	.29	48	.20
1979 Mercedes Benz 240D	.35	58	.25
1979 Mercedes Benz 300D	.83	138	.53

As these results show, levels of particulate emissions from these high mileage Oldsmobiles were above the 1982 standard. However, when these vehicles were produced, no such standard existed and probably no real effort was expended on reducing particulate emissions. In the search for a correlation between particulates and unburned hydrocarbons, no realistic relationship could be found on these twenty vehicles. Also evident in our sample is the lack of dependence on mileage for particulate emissions.

Fuel Economy

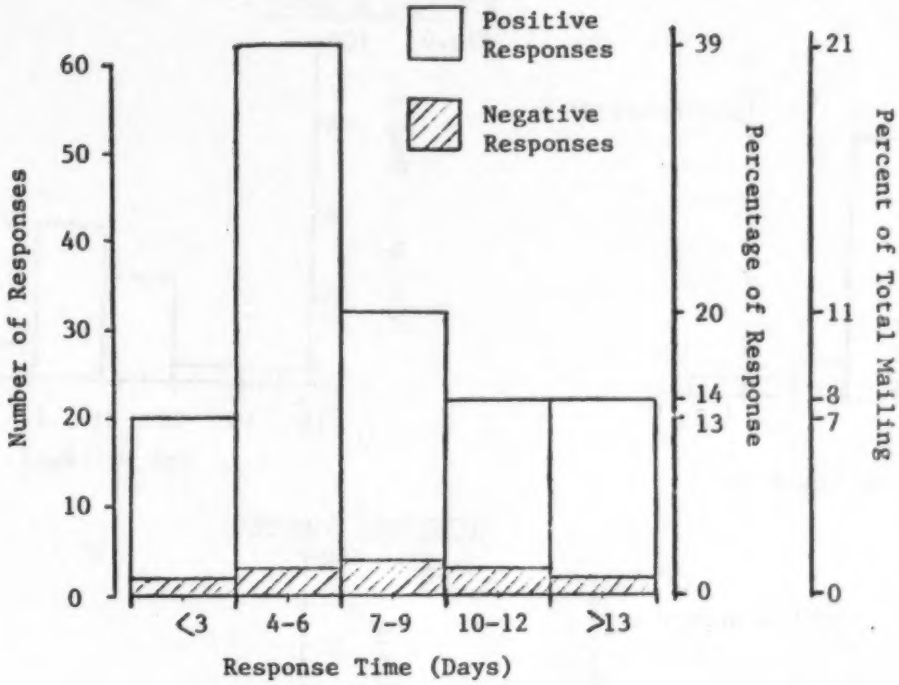
Miles-per-gallon (mpg) figures over both the FTP and HFET were calculated for each test sequence. The average fuel economy of the sedans and wagons were compared to the appropriate values listed in EPA's Gas Mileage Guide. This showed that the sedans average about 102% of the Guide's FTP values and 105% of the HFET. The two wagons average 104% and 106% of the Guide's FTP and HFET values, respectively. The questionnaire completed by each vehicle owner included questions which asked for the owners estimate of fuel economy under

city, highway, and combined driving conditions. Of those that responded, the sedan owners' figures were 100% of the Guide values for the FTP, and 94% for the HFET and 99% for the combined mileage value. The two wagon owners gave only combined mileage values which were 116% of the comparable value obtained from Guide results. Responses of the owners were also compared to the actual test numbers generated in this program. In this case, the estimates by the Sedan owners were 98% of the FTP, 89% of the HFET and 95% of the combined. These values are shown graphically in Figure 9. The estimates by the wagon owners were 111% of the actual combined. One reason for the seemingly high estimates for combined city/highway operation may be that these owners operated their vehicles on the highway more often than the 55/45 mix prescribed for the combined value.

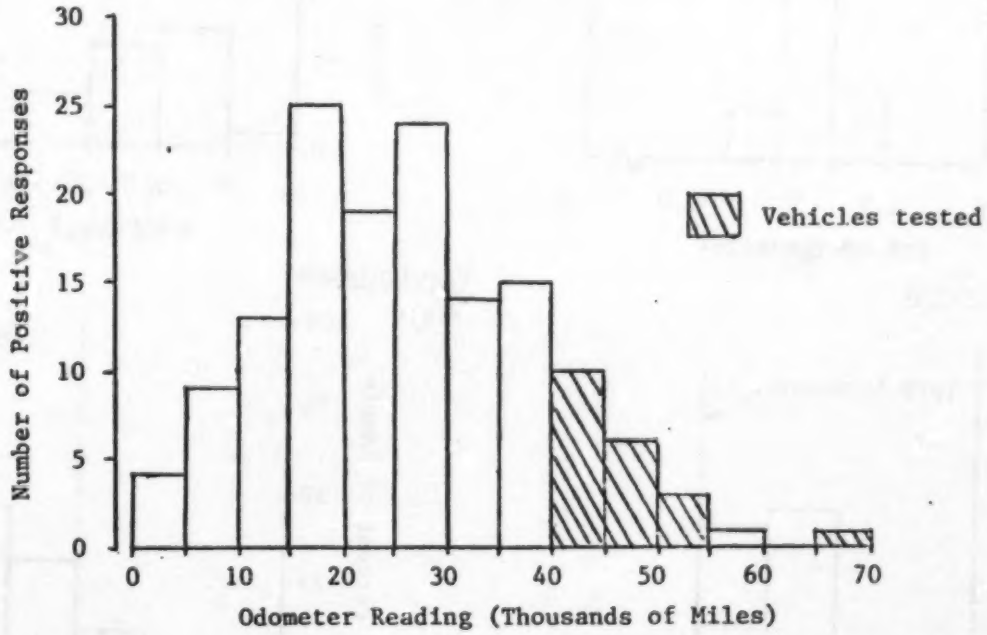
Conclusions

The average emission test results were quite similar to those resulting from the Certification process at 4,000 miles. Thus, it appears that the 350 CID Oldsmobile diesel engine demonstrates virtually no emission deterioration while in-use over its "useful life". City and Highway fuel economy values were also found to correspond closely with those published in the 1978 Gas Mileage Guide. Average particulate emissions of these diesels were found to be approximately 42% greater than the initial standard of 0.6 g/mile which is to become effective with the 1982 model year. HC and CO concentrations from the short cycle tests corresponded well with gram per mile values from the FTP in that both were quite low. The analyses of the Ames Test Samples have not been received and will be treated as a supplement to this report.

Response Rate
Figure 1

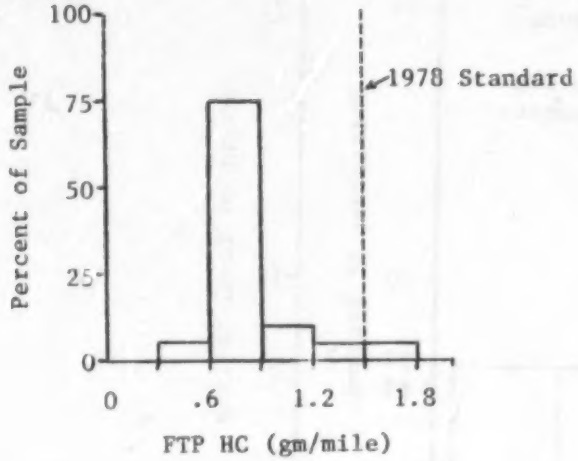


Odometer
Distribution
Figure 2



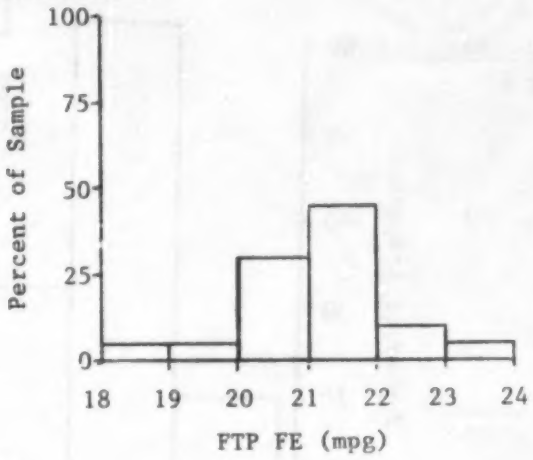
Hydrocarbons

Fig.3



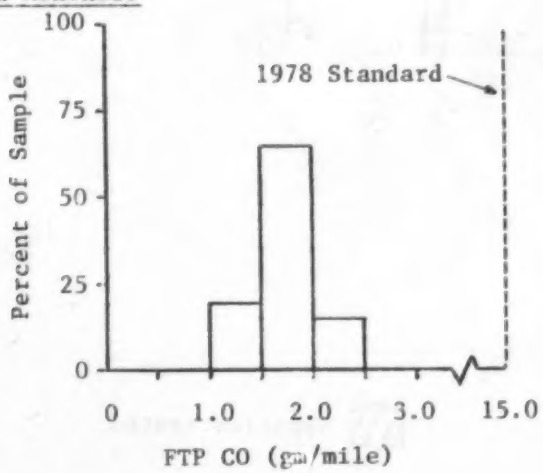
FTP Fuel Economy

Fig.6



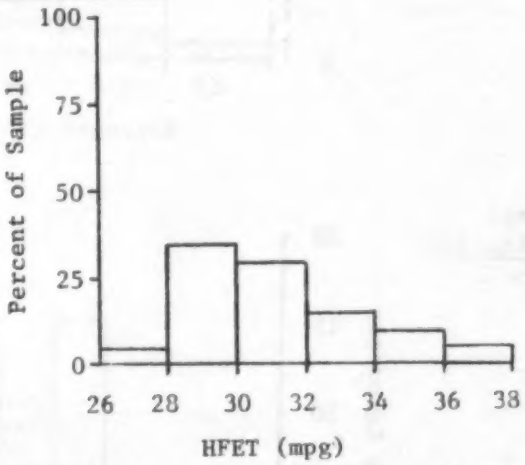
Carbon Monoxide

Fig.4



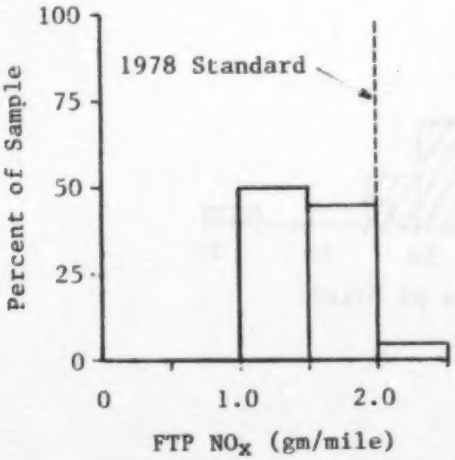
HFET Fuel Economy

Fig.7



Oxides of Nitrogen

Fig.5



Particulates

Fig.8

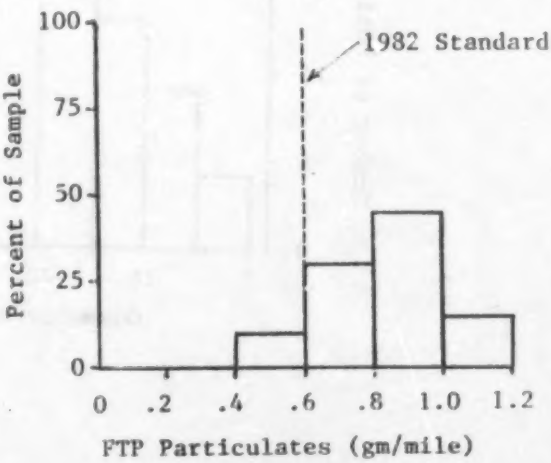
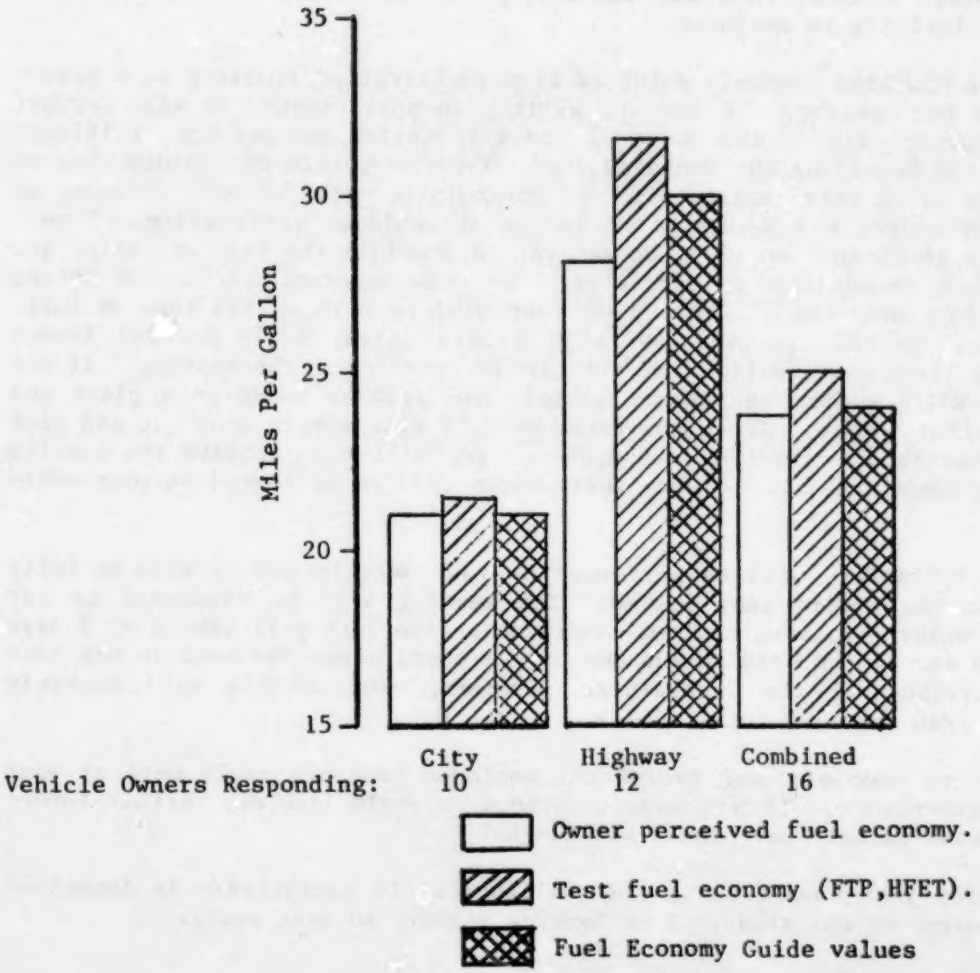


Figure 9

Testing of High Mileage
1978 Oldsmobile Diesels

Comparison of Owner Perceived MPG to
Test and Fuel Economy Guide Values



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

Dear Vehicle Owner:

As I am sure you are aware, the nation's air pollution problem is a very serious matter. You may be able to contribute significantly toward its improvement and be rewarded for your cooperation. The U.S. Environmental Protection Agency (EPA) is currently involved in a number of programs to reduce air pollution. One of these is to determine the emissions from in-use passenger cars equipped with diesel engines. This testing will be conducted at EPA's Motor Vehicle Emission Laboratory in Ann Arbor. A brochure describing our facility is enclosed.

Your vehicle has been randomly selected from registration listings as a possible vehicle for testing. If you are willing to participate, we will further consider your vehicle on the basis of the information you provide us through completing and returning the enclosed card. Once we obtain the information on make, model, model year, engine size and accumulated miles of your vehicle, we can randomly select a representative sample of vehicles for testing. Should your vehicle be chosen, we will contact you to schedule the test and offer you the following incentives to participate in this program: (1) a $50 United States Savings Bond and (2) return of your vehicle with a full tank of fuel. In addition, we will provide you with a late model, fully insured loaner vehicle for you to use while your vehicle is undergoing the testing. If you desire, we will deliver the loaner vehicle and pick up yours at a place and time convenient to you. After the test, we will also return your car and pick up the loaner vehicle in the same manner. You will also receive the results of the emissions and fuel economy tests which will be performed on your vehicle.

No unusual operations will be performed on your vehicle and it will be fully insured for the entire test period. The testing will be conducted in our laboratory under simulated driving conditions. The test will take 2 or 3 days to complete due to the need to run one of the tests after the vehicle has been parked overnight in the laboratory. However, your vehicle will probably accumulate less than 100 total miles.

We ask you to complete and return the enclosed postpaid reply card at your earliest convenience. If you have questions or would like any further information, please contact Gary Jones at 668-4427.

Thank you for your cooperation; your willingness to participate is important to the accuracy of our study. I am looking forward to your reply.

Sincerely,

Charles Gray

Charles L. Gray, Director
Emission Control Technology Division

Appendix A

Name_____Address_____

City_____State_____ZIP_____

Home Phone_____Best Time to Call_____

Business Phone_____Ext.____Best Time to Call_____

Make of Vehicle_____Model_____Year_____

Odometer Reading_____Engine Size_____

☐ Yes, I would like to participate in the program.

☐ Sorry, I have chosen not to participate in the program.

☐ I would like to have more information.

OMB Approval 158-R0106

EPA

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EPA 335

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Agency

Washington DC 20460

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Ann Arbor, MI 48105

EPA FORM 1320-6 (REV. 1-78)

Appendix B

EPA DIESEL TESTING PROGRAM

Participant Information

NAME: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

HOME PHONE: _____ WORK PHONE: _____

Bond Information

OWNER: _____ S.S.#: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

CO-OWNER/BENEFICIARY: (Circle One) _____

Vehicle Information

MODEL YEAR: _____ MAKE: _____ MODEL: _____

VIN: _____ LICENSE NO.: _____

ENGINE FAMILY: _____ ODOM: _____

NOTES ON CONDITION OF TEST VEHICLE: _____

_____

_____

EPA REPRESENTATIVE: _____ DATE: _____

PARTICIPANT'S SIGNATURE: _____ DATE: _____

CONDITION OF VEHICLE UPON RETURN: _____

ODOMETER: _____ DATE: _____

PARTICIPANT'S SIGNATURE: _____

Appendix B

Vehicle Exchange Agreement

The U.S. Environmental Agency (EPA) is furnishing you a 1979 Oldsmobile Cutlass (License No. _____) as a temporary replacement for your _____ (License No. _____). This agreement is subject to the following terms and conditions:

1. You agree to be careful in the use of the loan vehicle and to return it to an EPA representative within five days together with all tires, tools and accesssories and in as good interior, exterior and perating condition, normal wear and tear excepted, as when it was received by you.

2. You also agree that it will not be used to carry passengers or property for hire or to push or tow any vehicle or trailer. The loan vehicle may also be operated by another person provided that your permission is given. All such operators must be at least 21 years of age, duly qualified and licensed and listed below.

3. You acknowledge personal liability for all charges, fines and costs for parking, traffic or other legal violations assessed against the loan vehicle while it is in your possession.

4. You agree to release and hold EPA harmless from any liability for loss of, or damage to, any property left, stored or transported in vehicle by you or any other person during or following the term of this agreement.

5. EPA, in turn, agrees to be fully responsible for any and all damage occuring to your vehicle while in EPA's possession.

6. EPA also agrees to indemnify and hold you harmless of any repairs, damage, loss or liability sustained by you by reason of accident or damage to your vehicle while in EPA's possession.

7. EPA further agrees to be careful in the use of your vehicle and agrees to return it to you in as good interior, exterior and operating condition as when it was received by EPA.

In consideration of a $50 Savings Bond, I agree to loan my vehicle to EPA for this test program.

Owner's signature: _____ Date: _____

EPA Representative: _____ Date: _____

Principal Driver:

_____ License _____ Exp. Date _____

Other Drivers (note relationship to principal driver):

_____ License _____ Exp. Date _____

_____ License _____ Exp. Date _____

_____ License _____ Exp. Date _____

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

To Whom It May Concern:

This 1979 Cutlass (VIN 3R47F9M515731, Michigan license plate JFM 448) has been leased to the U.S. Environmental Protection Agency in support of a vehicle emission testing program. In turn, it has been loaned to the person identified below while his vehicle is being tested at our laboratory in Ann Arbor. Besides this principal driver, other persons which have his permission are also authorized to operate this vehicle. The names and license numbers of these drivers are also listed below. This loan agreement is valid for five days from the date shown.

If you have any questions, you may contact _____ or _____ at the EPA at 668-4200. The home telephone numbers of each are _____ and _____, respectively.

Owner's signature: _____ Date: _____

EPA Representative: _____ Date: _____

Principal Driver:

_____ License _____ Exp. Date _____

Other Drivers (note relationship to principal driver):

_____ License _____ Exp. Date _____

_____ License _____ Exp. Date _____

_____ License _____ Exp. Date _____

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

March 7, 1980

Mr. John Doe
123 Any Street
Dieselville, USA

Dear Mr. Doe:

Listed below are the emission results on your 1978 Oldsmobile which was tested in our laboratory.

	Unburned Hydrocarbons (HC)	Carbon Monoxide (CO)	Oxides of Nitrogen (NO_x)	Fuel Economy City	Fuel Economy Highway
Your Vehicle:	.85	1.65	1.40	21.3	31.3
1978 Standards:	1.5	15.0	2.0	---	---
EPA Fuel Economy Ratings:			Sedan:	21	30
			Station Wagon:	19	27

The emission results are in grams per mile while fuel economy is in miles per gallon. Enclosed is an explanation of how the test was performed and the Federal exhaust emission standards for passenger cars of recent model years. We have begun processing the savings bond and you should receive it within a week or two. Thank you very much for your participation in this program.

Sincerely yours,

Gary T. Jones
Technology Assessment and Evaluation Branch

Enclosure

Appendix B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

Dear Vehicle Owner:

Thank you for your cooperation and willingness to participate in our program. I regret that your vehicle has not been chosen for testing. Our current effort involves only vehicles which have accumulated a large number of miles. At this time, the cutoff point is 40,000 miles. Should your vehicle become a candidate due to a vacancy or cancellation in the current program, we will contact you to reaffirm your willingness to participate. We may also need additional vehicles for new programs and will keep your card on file. If you have changed your address or would like to update your vehicle information, please fill out the enclosed card and return it at your earliest convenience. You may also contact me by telephone at 668-4427 if you have any other questions.

Sincerely,

Gary T. Jones, Project Officer
Emission Control Technology Division

Appendix C

Vehicle No.	Model	Odometer	VIN	Purchased Vehicle	Driving Pattern				Driving Purpose				Distance Between Home and Lab	Number of Times Engine is Started Per Day	Fuel Economy Records Kept Accurately	Owner Estimated		
					Expressways	Major City St.	Other City St.	Rural Roads	Work	Shopping	Non-Work Business	Other				City Driving	Highway Driving	Combined
01	88	44866	3N69N8M169662	5/78	S	S	S	S	L	L	A	L	24	16	No	20	30	---
02	88	44844	3N69N8M139796	12/77	S	S	S	S	M	S	L	S	45	2	No	---	27	---
03	98	46712	3X69N8M146026	11/78	S	S	S	L	L	L	A	L	35	15	Yes	19	26	22
04	Wgn	44809	3Q35N8X206077	9/78	M	L	L	L	S	S	L	M	30	10	No	---	---	25
05	88	57169	3N69N8M167629	3/78	A	L	L	L	A	L	L	L	34	2	Yes	---	---	25.5
06	88	53116	3N37N8M238062	7/79	A	L	L	L	L	L	A	L	33	10	Yes	21	28	23.5
07	98	54300	3X69N8E148344	4/78	A	L	L	L	A	L	L	L	103	2	No	---	---	27
08	98	50400	3X69N8E160153	5/78	S	S	S	L	L	L	A	L	47	10	Yes	---	---	21
09	Wgn	41000	3Q35N8X120515	11/78	S	S	S	S	S	S	S	S	60	4	No	---	---	26
10	98	44300	3X69N8M212747	7/78	M	S	S	L	S	L	M	S	50	6	Yes	---	---	24
11	88	69050	3L69N8M115049	10/77	S	S	S	S	A	L	L	L	10	3-4	No	---	---	23
12	98	50327	3X69N8M235963	7/78	A	L	L	L	L	L	A	L	25	12	No	22	30	---
13	98	49116	3X69N8M211569	5/78	S	L	S	L	M	L	L	S	33	3	Yes	---	---	22.5
14	88	44343	3N69N8M235630	10/78	A	L	L	L	M	L	S	S	24	6	Yes	---	31	24.5
15	88	42159	3N37N8M208132	5/78	M	S	L	L	A	L	L	L	20	4	Yes	19	26	23
16	98	42807	3X69N8M152530	1/78	S	S	S	S	L	L	M	L	50	5	No	18	28	23
17	88	41282	3N69N8M151298	1/78	A	L	L	L	A	L	L	L	20	6	No	24	31	---
18	88	49759	3N69N8M239827	9/78	M	S	L	L	L	L	S	S	25	4	Yes	21	24.5	23.5
19	88	46501	3N37N8M168314	3/78	M	L	L	S	S	L	S	L	50	2	Yes	23	29	26
20	88	47030	3N69N8M185964	3/78	A	L	L	L	A	L	L	L	30	4	No	25	28	27

Legend: S; Some (less than 20%)
L; Little (21% to 50%)
M; Most (51% to 75%)
A; All (more than 75%)

Appendix C

Vehicle No.	Model	Odometer	Any Performance Problems	Area of Problem	Satisfied with Performance	How Long Ago was Fuel Filter Changed (months)	How Long Ago was Air Cleaner Changed (months)	How Long Ago was Idle Speed Adjusted (months)	How Long Ago was Last Oil Changed (months)	Vehicle Maintained within Manufacturer's Recommendations	How Many Drivetrain Related Warranty Repairs	Nature of Warranty Repair	Brand Name of Fuel	Any Major Damage
01	88	48866	NO	NA	YES	0-6	0-6	0-6	0-6	YES	None	NA	Union 76	NO
02	88	44844	YES	H.S.	YES	24	24	Never	0-6	YES	None	NA	Tulsa	NO
03	98	46712	NO	NA	Mostly	0-6	0-6	Unknown	0-6	YES	3+	Inj.	Boron	NO
04	Wagon	44809	YES	P.A.	YES	Unknown	0-6	0-6	6-12	YES	3+	Other	Union 76	NO
05	88	57169	NO	NA	YES	0-6	0-6	0-6	0-6	YES	2	TCL.,F.P.	Various	NO
06	88	53116	YES	R.I.	YES	0-6	6-12	12	0-6	YES	None	NA	Various	NO
07	98	54300	NO	NA	YES	6-12	6-12	Unknown	0-6	YES	1	O.L.	Amoco	NO
08	98	50400	YES	HS	YES	0-6	0-6	0-6	0-6	YES	None	NA	Various	NO
09	Wagon	41000	NO	NA	YFS	0-6	0-6	Never	0-6	YES	None	NA	Amoco	NO
10	98	44300	NO	NA	YES	0-6	0-6	12	0-6	YES	None	NA	Tulsa	NO
11	88	69050	NO	NA	YES	6-12	0-6	Never	0-6	YES	1	T.C.L.	Gulf	NO
12	98	50327	YES	P.A.	YES	6-12	6-12	Never	0-6	YES	None	NA	Various	NO
13	98	49116	NO	NA	YES	0-6	6-12	Unknown	0-6	YES	None	NA	Various	NO
14	88	44343	NO	NA	YES	0-6	6-12	Unknown	0-6	YES	None	NA	Various	NO
15	88	42159	YES	P.A.	Mostly	6-12	6-12	12	0-6	YES	3+	O.L. Inj.	Marathon	NO
16	98	42807	NO	NA	YES	0-6	Unknown	Never	6-12	YES	3+	D	Gulf	NO
17	88	41282	NO	NA	YES	0-6	Unknown	Unknown	0-6	YES	None	NA	Marathon	NO
18	88	49759	NO	NA	YES	0-6	0-6	Never	0-6	YES	None	NA	Union 76	NO
19	88	46501	NO	NA	YES	0-6	0-6	0-6	0-6	YES	3+	O.L.	Various	NO
20	88	47030	NO	NA	YES	0-6	6-12	12	0-6	YES	3+	Inj.,TCL	Various	NO
													Union 76	NO

H.S.; Hard Starting
P.A.; Poor Acceleration
Inj.; Injectors
T.C.L.; Transmission Cooling Line
F.P.; Fuel Pump
R.I.; Rough Idle
D.; Driveability
O.L.; Oil Leaks

Appendix D

Testing of High Mileage 1978 Oldsmobile Diesels
Results of FTP and Highway Fuel Economy Tests

				FTP					HFET				
Veh.#	Model	Odometer (miles)	Test#	HC (g/mi)	CO (g/mi)	NOx (g/mi)	MPG	Particulates (g/mi)	HC (g/mi)	CO (g/mi)	NOx (g/mi)	MPG	Particulates (g/mi)
01	88	44866	1	0.85	1.5	1.50	21.2	-----	0.58	1.0	1.25	27.4	0.472
			2	0.87	1.5	1.44	20.2	0.942					
			3	0.92	1.6	1.49	21.1	0.953					
02	88	44844	1	0.71	1.6	1.83	18.4	0.987	0.36	1.0	1.43	26.4	0.512
			2	0.66	1.7	1.79	20.1	0.997	0.36	1.0	1.44	30.0	0.540
03	98	46712	1	0.73	1.6	1.72	20.4	0.755	0.35	0.9	1.46	28.8	0.398
			2	0.68	1.5	1.69	21.1	0.726	0.34	0.9	1.48	29.1	0.370
04	Wagon	44809	1	1.57	2.2	1.60	18.8	0.962	0.78	1.1	1.27	28.1	0.443
			2	1.42	2.1	1.58	19.2	0.956	0.77	1.2	1.28	28.2	0.458
05	88	57169	1	0.64	1.6	1.86	21.5	1.021	0.35	0.9	1.48	31.5	0.608
			2	0.60	1.7	1.79	20.7	1.037	0.36	1.0	1.59	29.3	0.688
06	88	53116	1	0.56	1.4	1.62	22.0	0.848	0.33	0.9	1.15	36.9	0.480
			2	0.54	1.5	1.75	21.4	0.875	0.32	1.0	1.31	31.4	0.507
07	98	54300	1	1.02	2.2	1.47	21.0	0.875	0.44	1.1	1.17	31.0	0.502
			2	1.03	2.2	1.46	20.9	0.921	0.44	1.1	1.12	32.1	0.428
08	98	50400	1	0.87	1.9	1.43	20.8	0.795	0.52	1.1	1.24	28.9	0.557
			2	----	1.9	1.43	20.8	0.949	----	1.1	1.24	28.2	0.587
09	Wagon	41000	1	0.64	1.6	2.04	20.5	1.000	0.34	0.9	1.63	29.5	0.493
			2	0.61	1.5	2.04	20.9	0.901	0.34	1.0	1.63	29.2	0.485
10	98	44300	1	0.86	1.6	1.40	21.7	0.675	0.39	0.9	1.21	31.2	0.335
			2	0.86	1.6	1.42	21.2	0.696	0.40	0.9	1.17	31.8	0.341
11	88	69050	1	0.87	1.6	1.73	22.3	0.951	0.52	1.0	1.39	32.3	0.641
			2	0.74	1.6	1.74	22.2	0.878	0.47	1.0	1.41	32.0	0.533
12	98	50327	1	1.69	2.2	1.37	21.5	0.796	0.98	1.4	1.13	29.1	0.394
			2	1.59	2.1	1.32	22.0	0.759	0.88	1.3	1.13	30.0	0.392
13	98	49116	1	0.60	1.6	1.32	21.1	0.767	0.40	0.9	1.09	32.0	0.396
			2	0.62	1.5	1.30	20.8	0.710	0.38	0.9	1.11	31.1	0.379
14	88	44343	1	0.79	1.7	1.40	21.1	0.785	0.53	1.0	1.11	31.1	0.450
			2	0.88	1.7	1.42	21.4	0.797	0.50	0.9	1.12	31.9	0.410
15	88	42159	1	1.21	1.8	1.18	22.0	0.620	0.67	1.0	1.01	33.0	0.279
			2	1.11	1.6	1.13	23.1	0.513	0.54	1.0	1.03	32.1	0.291
16	98	42807	1	0.62*	1.3	1.69	21.7	0.706	0.34*	0.8	1.29	34.1	0.356
			2	0.62*	1.3	1.69	21.7	0.706	0.31*	0.7	1.15	37.8	0.331
17	88	41282	1	0.60*	1.6	1.88	21.6	1.172	0.28*	0.8	1.27	36.8	0.582
			2	0.60*	1.5	1.82	22.4	1.197	0.28*	0.8	1.27	36.3	0.562
18	88	49759	1	0.60*	1.4	1.47	21.5	0.798	0.34*	0.9	1.32	29.3	0.387
			2	0.62*	1.4	1.53	20.9	0.807	0.31*	0.9	1.28	30.3	0.374
19	88	46501	1	0.71*	1.3	1.35	23.0	0.545	0.37*	0.8	1.25	30.9	0.319
			2	0.77*	1.4	1.47	20.9	0.559	0.37*	0.8	1.20	31.6	0.320
20	88	47030	1	0.57*	1.5	1.44	23.4	1.138	0.34*	1.0	1.27	32.8	0.523
			2	0.71*	1.6	1.36	24.6	0.995	0.34*	1.0	1.17	36.0	0.506

*The Heated FID was not working properly during these tests. The values shown are based on the Heated FID to Cold FID ratio from earlier tests.

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Appendix E

Testing of High-Mileage 1978 Oldsmobile Diesels
Results of Short Cycle Tests

Veh.#	Model	Odometer (miles)	Test#	50 MPH Cruise HC (ppm)	50 MPH Cruise CO (%)	Four Speed Idle: Neutral HC (ppm)	Neutral CO (%)	2500 RPM HC (ppm)	2500 RPM CO (%)	Neutral HC (ppm)	Neutral CO (%)	Drive HC (ppm)	Drive CO (%)	Loaded 2-Mode: 30 MPH HC (ppm)	30 MPH CO (%)	Idle HC (ppm)	Idle CO (%)
01	88	44866	1	12	.020	15	.030	--	--	15	.030	15	.030	15	.020	15	.030
02	88	44844	1	15	.020	12	.020	12	.150	12	.010	13	.020	12	.050	12	.010
			2	9	.020	10	.020	10	.020	10	.020	10	.020	10	.020	10	.020
03	98	46712	1	12	.050	15	.050	15	.050	15	.050	18	.050	15	.030	18	.050
			2	15	.030	40	.050	15	.035	20	.050	19	.055	15	.035	18	.040
04	Wagon	44809	1	20	.040	12	.040	18	.050	20	.075	20	.060	18	.050	20	.075
			2	10	.040	18	.075	15	.050	18	.075	18	.060	15	.040	18	.055
05	88	57169	1	10	.040	9	.040	15	.040	12	.050	15	.060	12	.040	15	.050
			2	15	.035	10	.030	0	.020	10	.030	10	.035	0	.020	0	.030
06	88	53116	1	12	.040	10	.040	10	.045	5	.035	8	.050	8	.035	8	.040
			2	15	.020	0	.020	0	.020	0	.020	0	.020	0	.020	0	.020
07	98	54300	1	10	.040	15	.075	15	.050	15	.065	15	.060	10	.040	15	.060
			2	19	.055	20	.060	20	.055	25	.075	25	.075	20	.050	25	.060
			3	12	.250	12	.060	20	.040	20	.060	20	.060	20	.050	20	.060
08	98	50400	1	15	.055	20	.075	15	.050	18	.075	18	.070	18	.050	20	.070
09	Wagon	41000	1	10	.040	10	.045	12	.050	12	.050	12	.055	--	--	10	.040
			2	10	.040	10	.050	8	.040	10	.040	15	.050	12	.040	10	.040
10	98	44300	1	12	.040	12	.040	12	.040	12	.045	12	.046	0	.019	0	.030
			2	8	.040	8	.060	8	.050	10	.055	12	.075	8	.040	10	.055
11	88	69050	1	5	.040	10	.040	12	.030	12	.030	12	.040	12	.030	10	.040
			2	10	.040	10	.060	8	.050	10	.055	10	.060	10	.040	10	.060
12	98	50327	1	13	.025	15	.060	18	.061	18	.062	17	.060	10	.042	8	.060
			2	10	.055	5	.070	8	.550	10	.065	8	.060	8	.040	8	.065
13	98	49116	1	5	.050	8	.040	10	.040	8	.055	10	.050	0	.035	11	.050
			2	11	.035	15	.050	15	.040	15	.050	18	.055	19	.040	20	.050
14	88	44343	1	7	.040	8	.040	10	.060	8	.040	10	.060	8	.035	10	.040
			2	10	.035	10	.050	12	.055	12	.050	12	.070	10	.045	12	.055
15	88	42159	1	3	.022	20	.030	20	.030	20	.030	25	.030	20	.020	25	.030
			2	5	.020	8	.030	8	.030	8	.035	8	.035	10	.025	10	.030
16	98	42807	1	8	.035	8	.030	8	.030	9	.025	8	.030	8	.030	8	.030
			2	8	.030	8	.020	8	.025	8	.025	8	.020	8	.030	8	.025
17	88	41282	1	2	.018	0	.018	2	.018	1	.018	2	.020	2	.018	2	.018
			2	0	.010	0	.010	0	.010	0	.010	0	.010	0	.020	5	.020
18	88	49759	1	3	.020	2	.020	2	.022	2	.018	2	.022	2	.025	2	.020
			2	5	.020	8	.020	10	.025	5	.020	8	.020	8	.025	5	.020
19	88	46501	1	5	.020	8	.025	5	.020	5	.020	5	.020	5	.020	5	.020
			2	0	.010	0	.010	0	.010	0	.010	0	.010	0	.010	0	.010
20	88	47030	1	0	.020	0	.020	0	.030	0	.020	0	.020	0	.020	0	.020
			2	2	.010	5	.020	5	.020	5	.020	5	.020	5	.020	5	.020